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COMMERCIAL FRESH PRUNE PRODUCTS--TECHNICAL FEASIBILITY

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COMMERCIAL FRESH PRUNE PRODUCTS--TECHNICAL FEASIBILITY
Processing Studies and Probable Costs

Since the close of the recent war, certain industrial trends have set in that adversely affect the fruit industries. Most important of these trends are the increase in costs of transportation and the decline in foreign markets.

As a result representatives of the prune industry, and in particular the California Prune Marketing Committee, have become interested in exploratory investigations of processing methods designed to yield new products that would meet, partially at least, the advances in costs and at the same time sustain and expand the market for prune products.

Prunes are an important crop in four States: California, Oregon, Washington, and Idaho. National production (fresh basis) varies annually between 500 and 700 thousand tons. Over 80 percent of the crop is usually dried. Prior to the war more than a third of the dried prunes were exported. In 1947 over half of the dried prunes were exported, but nearly all of these were shipments overseas under the Civilian Relief Program of the Department of the Army. The prunes were purchased by the Commodity Credit Corporation for price-support purposes.

It has seemed to industry men that processing of fresh prunes in a manner that yields such products as purees, single-strength juices (clarified or unclarified), or concentrated juices might broaden and extend the market. Prunes have nutritive properties similar to those of many other fruits. In addition they have a mildly laxative quality that, along with other properties, has made them a very widely used fruit. Processed fresh-prune products have attractive color and pleasing flavor.

The Western Regional Research Laboratory has started research on a project designed to obtain information on new products which might be prepared from fresh French prunes. This progress report on results obtained up to the present time is being released now at the suggestion of the California Prune Marketing Committee.

Processing Studies

To supply samples of product and to provide indicative data on yields and suitability of various pieces of equipment, Laboratory staff members have prepared the following products from fresh French prunes: puree, unclarified juice, clarified juice, and 2.5-fold concentrated clarified juice. Market outlets contemplated are as follows: for the puree--baby foods and other uses; for the juices--beverages, components of beverages, sirups, and pharmaceutical preparations. In the preparation of these products, operations were carried out at the rate of about 200 pounds of fruit per hour. The prunes were orchard-run, harvested at about midseason. Sorting was limited to removal of obviously unsound fruit.

Enzyme Inactivation

Prunes, like many other fruits such as apples and peaches, contain oxidative enzymes which cause the flesh to darken rapidly when the tissue is bruised or macerated. Before they are pitted or pureed, it is necessary to inactivate these enzymes or the fruit will darken rapidly and develop undesirable off-flavors. Heating prunes in flowing steam was found to be a satisfactory method of inactivating these enzymes. Steaming also loosens the red pigment located primarily in the skin. This action is considered quite desirable, because the pigments impart a pleasing red color to the clarified juice.

Heating was carried out as follows: Raw French prunes were loaded one layer deep on 2x3-foot stainless-steel trays (about 15 lbs. per tray), washed with sprays of cold water, and blanched in steam at 212°F. for 8 minutes. The blanched prunes were then cooled to about 100°F. in 4 minutes in a mist cooler. For large-scale operations a screw-type steam cooker should be suitable for use in the enzyme-inactivation step. Such equipment was considered in the estimations of cost discussed in subsequent sections.

Pureeing

Puree was prepared from the blanched prunes in a small paddle finisher, equipped with a 3/16-inch screen. The unit was too small to permit installation of brushes; therefore the standard metal blades were replaced with specially designed rubber paddles to reduce pit breakage. Yields averaged about 90 percent (based on the weight of the raw prunes). This yield includes weight changes during blanching and cooling as well as losses in pulping. While a small percentage of pits was broken in the pureeing operation, breakage was not sufficient to introduce the characteristic almond or "pit" flavor contained in the kernel of the seed. Pulping equipment of this type should be suitable for commercial operation.

Depectinizing

The product as obtained from the paddle finisher was thick and very difficult to press. Hence 0.1 percent of a commercial pectic enzyme preparation was added to the puree (at 100°F.), stirred in thoroughly, and the mixture was held at 100°F. for 2 hours. The resulting product was reasonably fluid. These enzyme preparations are commercially available at a relatively low cost and are frequently used in preparation of apple juice and wine.

Pressing

The pressing characteristics of the depectinized puree were further improved by the addition of 0.25 percent of paper pulp. The material was then pressed in a small rack-and-frame cider press. Best results were obtained when the puree was warm (about 100°F.). The product was cloudy and some sediment settled out on standing. The over-all yield of cloudy juice, based upon the weight of fresh prunes, was about 75 percent. The paper pulp must be highly refined, washed free of alkali and acid, and must not impart a taste to the product. Suitable paper pulp is available commercially. A coarse (diatomaceous earth) filter aid should be equally effective in improving pressability of the puree. A conventional rack-and-frame press would be suitable in commercial operation. The nature of the puree may make the pressing somewhat slower than the corresponding operation for apples.

Clarification

The cloudy juice was clarified in a plate filter, with medium-weight canvas filter cloths. The cloths were precoated with a medium-grade sintered diatomaceous-earth filter aid, at the rate of 8 grams per square foot of filtering surface. Filter aid was also added to the juice (0.1 percent by weight). The clarified product had a pleasing red color and characteristic fresh prune flavor.

Concentration

Concentrate (2.5-fold, by volume) was prepared from the clarified juice in a laboratory-sized glass falling-film evaporator. The operating pressure was 0.6 lb. per square inch absolute (30 mm. of mercury), which corresponds to an operating temperature of 85°F. The solids content of the feed was about 33 percent, and that of the product, about 67 percent. The concentrate was dark red, clear, and fluid enough to be handled easily. Higher evaporation temperatures common in commercial vacuum pans would probably not appreciably affect the color or flavor of the juice. Essence-recovery units were not found necessary, since the juice contains only small amounts of volatile flavor constituents. A commercial vacuum pan was considered in the following cost estimates.

Bottling

The products were heated to 195 to 200°F. and filled into 17 oz. bottles and No. 2 cans and sealed. The capped bottles were placed on their sides for 5 minutes to assure adequate heating of the caps and upper portion of the bottles. Bottles and cans of the products were cooled to about 100°F. by immersion in water, and cased.

Chemical Analyses

Chemical analyses of the clarified juice and the concentrate prepared therefrom are given in Table 1. Analyses for the puree and unclarified juice were quite similar except that a small amount of carotenoid pigment (28 parts per million) which may have some vitamin A potency, was found in the puree. These pigments, which are apparently in the pulp or fiber of the fruit, are removed during pressing and filtering. This should not be considered as favoring production of puree over clarified juice, as the amounts of carotene involved are so small that they have little nutritional value. Ascorbic acid (vitamin C) was found to be present only in small amounts.

Table 1

pH	Titratable acidity (as malid) %	Total solids %	Soluble solids (R.I.) %	Sugars %		Ascorbic acid (mg./100 g.)	Total carotenoids (as carotene) (ppm.)
				Reducing	Total		
			Clarified juice				
3.8	0.59	34.0	33.2	17.4	21.3	1.4	0.0
3.8	1.21	68.3	Concentrate				
3.8	1.21	68.3	67.3	36.5	43.9	4.0	0.0

Considerable information concerning fresh prune products is available in the literature. Mrak and Cruess (4) describe a method for preparing blanched prune pulp, while Eddy and Veldhuis (3) describe a method for preparing prune nectar. Cruess *et al*. (1, 2) outline experiments for preparation of fresh prune juice.

Probable Costs

The cost data supplied here are intended to serve as a general outline and guide to prospective manufacturers of fresh prune juice and concentrates. Consideration of relative importance of the various items of cost will aid the processor in proper evaluation of the specific conditions with which he is faced. The discussion may aid him also in avoidance of undue emphasis on minor items and failure to consider any of major importance. Thus these estimates require adjustment for specific conditions if they are to be used for accurate determinations of cost.

Assumed Commercial Process

For the following estimates, certain operating procedures are assumed, as mentioned in preceding sections (see also Flow Sheet attached, Fig. 1). Prunes are washed in a conventional washer-elevator. Sorting is done on a succeeding inspection belt. They are heated in a screw-type preheater into which live steam is admitted. The condensation of steam in the product may increase the subsequent yield of juice 15 to 20 percent. A conventional pulper, with appropriate paddles or brushes, removes the pits. The puree is cooled to 100°F. by a heat exchanger, introduced into storage tanks for depectinizing, and pressed with the aid of paper pulp.

For a cloudy product the juice is flash-pasteurized, bottled hot, capped, and cooled. Clarification (in the preparation of clear juice) requires use of a filter press with a filter aid. A conventional single-effect vacuum pan is adequate for the concentration step, as indicated by processing tests. A triple-effect, low-temperature concentrator would not appear to be justifiable from the cost standpoint.

Investment Costs

Investment costs for new equipment, new building, and land may be as shown below. The capacity assumed is 16 tons of prunes per 8-hour shift. Engineering costs are not included:

Plant for	Approximate investment cost (either pint or quart bottles)
Cloudy juice	$110,000
Clear juice	115,000
Concentrate	120,000
All three products	135,000

The costs of a plant producing only puree and the related processing costs are not considered separately. The additional cost of evaporation equipment in a concentrating plant is partially offset by a probable lower cost of bottling, capping, cooling, labeling, and casing equipment. There are several ways of setting up juice and concentrate plants, with investment costs less than those indicated. Some of them are outlined below:

1. Set up prune plant as an adjunct to an existing plant. (Use steam facilities, equipment, space, etc., already available.)
2. Obtain used building and equipment.
3. Rent suitable plant and possibly equipment.
4. Use tin cans instead of bottles. (The equipment required for cans is less costly.)
5. Modify process to use less and cheaper equipment, plant, and land. (Substitute labor where possible, less costly materials, lower priced land.)

In considering ways to reduce investment costs, one must also recognize the possibility of higher operating costs. Modifications in the process outlined may be necessary and these might result in a need for additional or more costly equipment.

Production Costs

Estimates of approximate costs of producing juice and concentrate from 16 tons of fresh prunes per 8-hour shift are included below. No selling, distribution, or product storage costs and no profit to the manufacturer have been considered. Interest on investment is allowed, and the assumed cost of prunes if $50 per ton.

		Approximate production cost per case	
Single-strength juice (about 28° Brix)		50-shift season	100-shift season
Cloudy	1,045 cases of 24 pints	$2.29	$2.15
Clear	1,045 " " " "	2.31	2.17
Concentrate (68° Brix)	333 " " " "	5.25	4.80

Relative Importance of Major Cost Components

Approximately three-fourths of the cost of producing juice in pints would be material cost--prunes, bottles, caps, labels, and chemicals. Comparing clear, single-strength juice with concentrate, both in pints, material costs per case are as follows:

	Juice		Concentrate	
	Amount	%	Amount	%
Cost of prunes, at $50 a ton	$0.76	43	$2.40	69
Bottles	.89	51	.89	28
Caps and labels	.08	5	.08	2
Chemicals	.02	1	.09	1
Total material costs	$1.75	100	$3.46	100

Because material costs are such a large proportion of total production costs, the commercial feasibility of this whole operation may well depend upon material costs alone. Ways of reducing material costs should be given careful consideration:

1. The price of $50 a ton for prunes is arbitrary. A prospective operator should use figures realistic for his particular situation. He should consider the possibility of processing smaller-sized fruit. Probably some grades of fresh prunes would make excellent juice even though they may not be suitable for drying. The yield of product from the various grades of fruit that might be available for processing must be determined.

2. The juice produced in the Laboratory was about 32° Brix. The dilution that would occur in the live-steam preheater may reduce the Brix to about 28°. A further dilution might be advisable to produce a juice with the same percentage of solids as occurs in other fruit juices. The cost of selling prune solids would thereby be increased, but cost per case of product, and selling price per bottle, could be decreased.

3. Tin cans might be used. A lower handling cost as well as a lower package cost could be achieved.

4. The use of bottles smaller than pints and quarts would reduce the unit selling cost but increase the overall cost of selling prune juice.

5. The advantage of the saving in container costs resulting from the concentration step is evident in the table above.

The attached nomograph (Figure 2) illustrates the effect on production costs of of various prune prices and bottle sizes. Only the material costs of the containers, bottles, caps, labels, and cartons are considered. The nomograph is used in this manner: Assume that prunes will cost $50 a ton and that the product will be bottled in pints. A line is drawn as illustrated, or a straightedge laid, between $50 on the left-hand column and pints on the right. Under the heading "Concentrate," a material cost of $3.37 is indicated, and under "Juice," a cost of $1.73. Both of these values are also illustrated in the table above. Similar determinations can be made for other prune costs and bottle sizes. The various cases of bottle sizes do not all contain the same quantity of liquid; therefore the calculations are made on the basis of 24-pint cases, or 3 gallons of liquid. Thus, if prunes cost $50 a ton and half-pint bottles are to be used, the indicated material costs for 3 gallons of liquid are $3.84 for concentrate and $2.20 for juice. In addition to the higher cost of $0.47 for materials when half-pint instead of pint bottles are used, labor and other processing costs will also be higher for the smaller containers.

Estimated labor costs are around 15 cents a case for juice and 40 to 45 cents for concentrate and account for less than 10 percent of the total production cost. Any normal variation in labor costs would have but little effect on the commercial feasibility of the processes under discussion.

The large investment cost for a plant operating such a short season imposes a relatively high overhead charge on the product. The effect of increasing the number of shifts operated during a season is shown in the table under Production Costs and in the table below. Use of the plant for other products in off-seasons would further reduce costs. Substitution of labor for machinery will decrease investment costs, but it is doubtful whether unit processing costs would thereby be reduced.

The production costs calculated apply only to a plant running full time on one product. If a plant were built to produce all three products, and operated one-third of the time (with production divided equally among the three products) costs would be increased as shown below, because some of the equipment is applicable to only one or two of the products. The concentrator, for example, would be idle two-thirds of the time. Yearly charges on the related investment cost must, therefore, be spread over a smaller number of cases.

	50-shift season	100-shift season
Cloudy juice, per case	$0.02	$0.01
Clear juice, " "	.03	.01
Concentrate " "	.35	.18

Cost Advantages of Producing a Concentrate

A comparison of the cost of producing juice and concentrate can best be made from a consideration of total cost per shift. Regardless of the number of cases of output, the same total prune solids are bottled for each product. In producing the product from 16 tons of prunes, in a 50-shift season, total costs involved for each product are estimated as follows:

	Estimated cost per shift	
	Pints	Quarts
Prune juice, cloudy	$2,390	$2,180
" " clear	2,420	2,210
Prune concentrate	1,750	1,670

The total cost of producing the prunes as a concentrate is approximately three-fourths of the cost of producing the prunes as a juice. This lower total cost, plus the savings that would be possible in transportation and storage charges, should favor production of the concentrate, especially for shipping to distant markets.

Literature Cited

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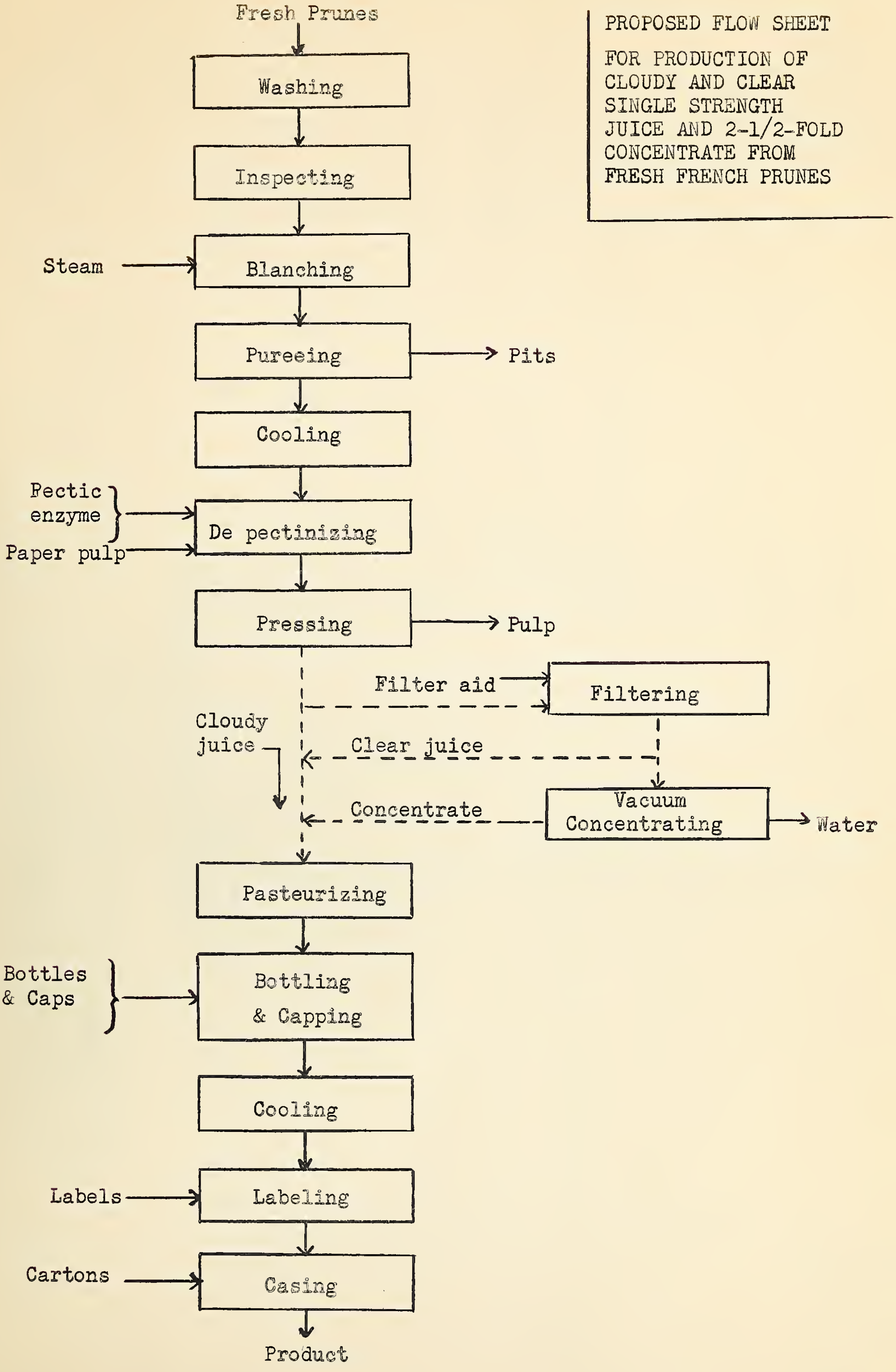
2. W. V. Cruess, W. Rivera, G. Chong, and A. Gibson: Juice from Fresh Prunes, Canner 110(1):22, 68, Jan. 7, 1950.

3. C. W. Eddy and M. K. Veldhuis: New--Nectar Made from Fresh Prunes, Food Indus. 14(3):46-7, March, 1946.

4. E. M. Mrak and W. V. Cruess: Utilization of Surplus Prunes, Calif. Agr. Expt. Sta. Bul. 483, pp. 5-16. 1929.

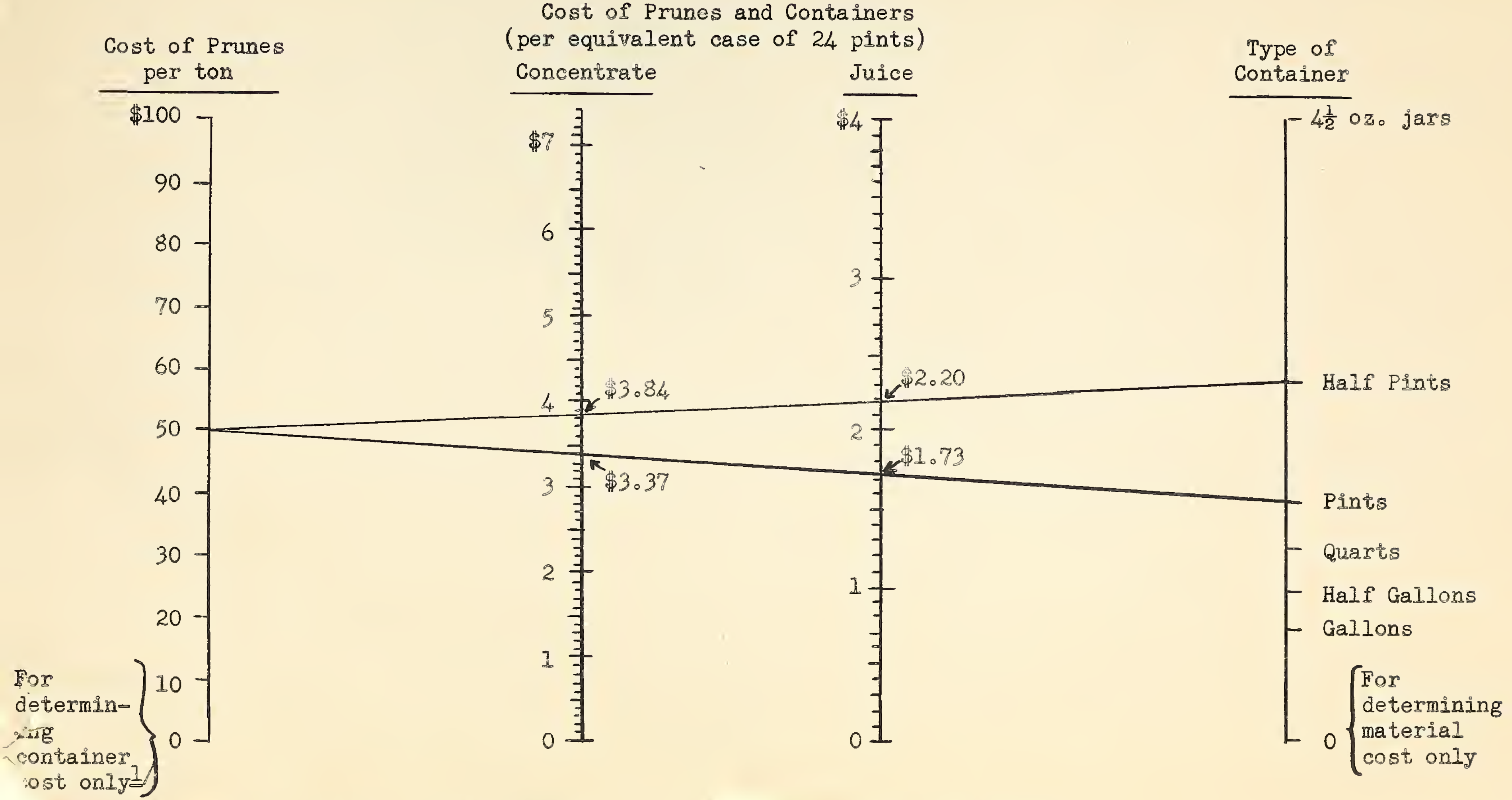
Figure 1



PROPOSED FLOW SHEET

FOR PRODUCTION OF
CLOUDY AND CLEAR
SINGLE STRENGTH
JUICE AND 2-1/2-FOLD
CONCENTRATE FROM
FRESH FRENCH PRUNES

Figure 2 -- Determination of Approximate Cost, in Equivalent Cases of 24 Pints, of Prunes and Containers - Using Various Prices for Prunes and Different Sizes of Containers.
Place straight edge at any point on the left hand and right hand columns. Intersections of the columns between will show costs of materials for concentrate and juice.



1/ Container cost includes: Bottle labels, and cartons.